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Relationship between Cost of Sugarcane Production and Cost of Maize Production among Farmers in Nyanza Region, Kenya

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Abstract

Despite increased demand for sugarcane as an intermediate input in animal feeds production, bioethanol and food stuff, its significance on farmers' livelihood farmers in Kenya is mixed. There are sections of farmers uprooting this cash crop in favour of maize, a staple food in order to enhance their food security status. Additionally, some policy pronouncement encourages the diversification of sugarcane by intercropping it with other food crops. Through the application of correlation research design, this paper adopted the Structural Equation modelling to analyse primary data collected from rural households in the counties of Homabay, Kisumu and Migori, in Nyanza region to establish the relationship between sugarcane and maize production from their corresponding costs of labour, land and capital. The study concludes that as sugarcane production costs increases, food production cost also increases significantly though inelastic. Hence, ad-hoc increases in cost of sugarcane production must be tamed if maize production is to be achieved.

Keywords: Farmers, maize production, structural equation model, production cost, sugarcane production

JEL Classification: Q110; Q120

Introduction

World sugarcane production and harvest have increased overtime due to an increase in demand for industrial bioethanol, animal feeds and food stuff. This is reflected in the increase of production from 448 million tonnes on 8.9 million hectares in 1961 to over 2 billion tonnes on about 27 million hectares by 2017. The largest world sugarcane production takes place in Brazil and India and accounts for 37 percent and 18.7 percent respectively (El Chami et al., 2020).

World ranking indicates Kenya as the 31st largest sugarcane producer and the 5th in Africa after South Africa, Egypt, Sudan and Swaziland. Sugarcane production in Kenya is done on 73,065 hectares with an average yield of 72,020 kilograms per hectare. With such levels of output per hectare, Kenya occupies the 35th position worldwide (AtlasBig.com, 2021). With such yield, the trend, from 1980 to 2010, alludes to an increase in production overtime. Nonetheless, this is attributed to increases in acreage of land planted and not on the yield per acre (Kenya Sugar Industry, 2009). Kenya Sugar Board [KSB] (2012); Mati and Thomas (2019) showed that output per acre declined in the years 2000s and 1990s due to poor land management, agricultural practices, delayed sugarcane harvesting and the usage of low-quality sugarcane varieties. In 2016, total sugarcane production degenerated from 639.7 thousand tonnes to 376 thousand tonnes. This was attributed to conversion of sugarcane plantation land in favour of production of food crops, specifically maize and soya beans (Kenya National Bureau of Statistics, 2018).

Although Kenya National Bureau of Statistics (2018) portrayed an indirect correlation between sugarcane production and food insecurity among households, given land, the general linkage between sugarcane production and food security is still controversial in other dimensions. For instance, Ramashala (2012) as well as Swinnen and Squicciarini (2012) established that sugarcane production increases households' income thus increasing households' ability to afford food. Wiggins et al., (2015) observed that with increased cash crop production, food production from the perspective of availability, had been sustained. Mendoza et al., (2014) observed that increased sugarcane production served the needs of the sugar mills and by extension, also improved the lifestyle of the farmers. Contrastingly, Terry and Rhyder (2007), Tyler (2008), Harvey and Pilgrim (2011), and Anguyo (2014) observed that adapting sugarcane farming led to food deficiencies among the small-scale farmers, especially when linked to land use. In Kenya, Masayi and Netondo (2012) and Lihasi et al. (2016) also reported that sugarcane monoculture led to a drop in food crop production among the small-scale sugarcane farmers in Mumias. In Kigali, strenuous work conditions, coupled with low wage rates in sugarcane plantations make it difficult for labourers to support their households. This situation has resulted in disaffection to the level where all year-round, labourers lament about deteriorating position and their inability to vary their food requirements since the emergence of sugarcane agriculture (Lankhorst & Veldman, 2011).

The need to study maize production was prompted by findings by Mohajan (2004), which observed that Kenya, compared to her neighbours, is the largest importer of food and other agricultural products. Surprisingly, maize, a staple food crop, also experiences a national supply deficit and has to be imported. Cited by Kenya Agricultural and Livestock Research Organization [KALRO] (2021), Food and Agricultural Organisation (FAO) indicated that 65 percent of the daily per capita cereal consumption comes from maize; besides, its production accounts for 25 percent of agricultural employment and greater than 20 percent of the total agricultural production. Notwithstanding, its production has fallen from an average of 4.4 million tonnes to about 3.2 million tonnes in 2022 (Gitonga & Snyder, 2022). This is due to climate change, increased human activities and increased spread of invasive pests and diseases from pathogen and vector evolution. From the different County Integrated Development Plans (CIDPs), it is evident that there is food insecurity concern in Nyanza region since every county government in this region has prioritized to address it within their jurisdiction (County Government of Homabay, 2017; County Government of Kisumu, 2018; County Government of Migori, 2018). Similarly, Kenya's 'big four agenda' isolated food security and committed to ensure that Kenya attains 100 percent food and nutrition security (The National Treasury and Planning, 2020).

In Nyanza region (Migori, Homabay & Kisumu), there is humid temperature (Rao, et al., 2015), which is very useful for the growth of cash crops such as sugarcane, cotton and coffee; food crops such as sorghum, millet, maize, vegetables and beans; and rearing of domestic animals such as cows, sheep and goats (Manyong et al., 2005). Given this conducive farming conditions, 55.9 percent of Nyanza's total arable agricultural lands are under sugarcane production yet farmers from this region still suffer from food shortage (Rao, et al., 2015). The compelling argument is that the financial returns from sugarcane production are insufficient to cater for the deficits in food production (Masayi & Netondo, 2012); Lihasi et al., (2016). Close to 85 percent of the households realize food insecurity for at least 3 months each year due to natural disasters, limited access to credit or lack of knowledge of credit use, lack of adequate income, presence of non-local markets to increase their agricultural outputs and high rates of HIV/AIDS (CARE, 2010). In Kisumu region

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alone, 53.6 percent of the households are food insecure (Urban Futures, 2018). Moreover, donations have been pumped into these areas in order to address food insecurity (Thuita, 2016).

Although most studies indicate sugarcane production having an adverse effect on food production, it is still a highly regarded cash crop among farmers and policy confusion still amounts on its production (Ochieng & Raballa, 2018). Farmers are still encouraged to diversify their production by intercropping sugarcane with other food crops to end the perennial dependence upon sugarcane alone and increase the likely yield of the crop per unit area (Singh, et al., 2019). If this is done, the intercropped plants benefit from irrigation, fertilization and minimal weed infestation (Shamsi et al., 2003). Interestingly, Gitonga and Snyder (2022) also observed reduced maize production due to increased sugarcane production uptake.

Past literatures have shown that land, labour and capital are critical components in sugarcane production, but the most important component is land (Wiggins et al., 2015; Bernardo et al., 2019; Rout et al., 2017). Similarly O'Kane (2011), Abah and Petja (2015), Di-Marcantonio et al., (2014) and Agidew and Singh (2018) documented the importance of land, labour and capital on food production. To this end, Wiggins et al., (2015) investigated the competitive or complementarity that exists between cash crop production and food crop production since there were concerns that cash crop production in Africa would displace food production. From their findings, households' access to food due to the competing input needs from cash crop farming, may still suffer from low incomes because of lack of labour, land and capital to produce more.

Given these shifts, this study investigated the level of association between the cost of input factors used in maize production as well as cost of input factors used in sugarcane production. Further, this study investigated the overall interaction of cost of inputs in sugarcane production on the cost of input factors used in maize production.

The Reviewed Literature

Sugarcane species *(Saccharum officinarum)* belongs to the grass family *Gramineae*. Many world economies use it as inputs in the production of alcohol, yeast, sugar and other derivatives. It grows to a height of 10-20 feet with a single plant bearing many thick, solid and aerial stems, coming in different colours ranging from white, yellow, black, dark green, purple, red or violet. The stems are jointed and the inter nodes are smaller at the base and increase in length, until it terminates in inflorescence (Ramashala, 2012).

Mendoza et al., (2014) established that sugarcane production must be increased to serve the needs of the sugar mills. Such an increase also leads to the betterment of the farmers' lifestyle. As such, the value chain analysis of sugarcane in Philippines, affirmed that good land preparation, sugarcane variety, proper scheduling of planting and fertilizer application are critical in ensuring yields. In order to attract private investment and generate employment, Olukunle (2016) used both primary and secondary data to investigate the profitability and competitiveness of sugarcane enterprises in Nigeria. By using information on farm size, size of operations, equipment costs for storage, production and processing, revenues, fixed assets, labour (hired and family), prices for input and output, interest and wage rates, the Kenya National Bureau of Statistics (2018)) reported the dominance of fertilizer among overall sugarcane production costs. This was followed by the cost of hired labour, cost of renting equipment and the interest rates paid on accounts. Dlamini and Masuku (2013) investigated the determinants of sugarcane profitability in Swaziland. Results from multiple linear regression equation in the study showed farm sizes, labour and fertilizer costs as well as sucrose prices as significant in determinants of sugarcane profitability. Nazir et al. (2013) used a Cobb Douglas function to determine the factors that affected sugarcane production in Pakistan. Results revealed costs of DAP, urea, land preparation, farm yard manure, weeding, seed application and irrigation costs, were critical in influencing sugarcane growers' returns. However, they also pointed out that sub-optimal sugarcane production resulted from high input prices, lack of capital, low output prices and late payments. Besides, technical constraints such as land preparation, deficient scientific knowledge, seeds, insecticides, pesticides, natural calamities and insufficient irrigation, also contributed to the dismal sugarcane output.

Decline in sugarcane production among smallscale sugarcane growers in South Africa prompted Zulu et al. (2019) to investigate the factors affecting sugarcane production. Using a cobb-Douglas function, the results from their study cited and indicated late harvesting, late fertilizer application and late chemical application as the fundamental challenges that affected sugarcane production. However, labour and chemical application costs were positive and statistically significant in determining sugarcane production.

Maize, *zea mays,* is a grass belonging to the *Poaceae* family, (Plant Village, n.d). It forms an important aspect of food in Kenya. Maize can be consumed in its grain form or can be processed into maize flour, vegetable oils and also into beer, after being fermented. After harvesting, its left overs can either be used as fodder or processed into silage (Greenlife Crop Protection Africa 2021). Being a part of food crop, Di-Marcantonio et al., (2014) assessed the impact of policy, governance and access to food production especially on domestic food availability. By studying agricultural inputs, urbanization and agricultural exports, ordinary least squares estimation indicated that agricultural inputs such as land, irrigation and labour, were significant in influencing food productivity.

Food production and poverty are rife in Ethiopia and these situations are made worse by the ravaging droughts and inadequate public policy. To ascertain the average daily food availability to each person, Household Food Balance (HFB) model established that family size, labour force, relief support, agro-ecological zone, farming experience as well as household head ages, were significant determinants of the rural food insecurity (Agidew & Singh, 2018).

Mwavu et al. (2018) focussed on land use to determine the contribution of sugarcane farming towards food production. From their analysis, majority of the farmers were not interested in sustaining their food production and therefore suffered from lack of adequate and nutritious food. Even though sugarcane farmers generated income, food insecurity still persisted among them. Wiggins et al. (2015) investigated whether cash crops and food crops are competitive or complementary. Given the fear that cash crop production would displace food production in Africa, concern was that small scale farmers would be exposed to market risks due to the dominance of the large firms. It emerged that households practising sugarcane farming had the risk of facing low incomes emanating from the fundamental production factors (labour, land and capital) to produce more.

In Tanzania, it was established that sugarcane growing stimulated business growth around some specific towns where it was being practised. Besides, returns from sugarcane enabled the farmers to fund other crops, build houses and educate children. However, it was noted that expanding sugarcane plantation led to land scarcity. Similarly, the costs of purchase of land also become expensive and continued expansion led to the replacement of food crops (Sulle & Smalley, 2015). On the same note, Urassa (2015) also established that education also plays a role in maize yields. However, access to fertilizers, improved seeds, chemical inputs and extension services are also important in increasing production.

With regard to the relationship between sugarcane production and food production, Intarapoom et al. (2019) used quantitative methodological approach to investigate the impact of

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sugarcane farmland on rice production in Thailand. The study progressed by getting the quotient between the sugarcane planting area and the rice plantation area in the following manner; 100:0, 75:25, 50:50, and 25:75 respectively. From the report, households who considered sugarcane to rice land ratio of 100:0, had low food production level than the rest of the groups while households with sugarcane to rice land ratio of 25:75, had the greatest food production level.

Gunatilake and Abeygunawardena (2011) considered food production as a contender in studying sugarcane bioethanol economic feasibility in India. From the findings, production of sugarcane to make bioethanol compromised food production and therefore recommended non-production of bioethanol using sugarcane juice since it was neither socially desirable nor economically feasible. In their study, three different regions with different climatic conditions were studied and this led to the existence of variances in production cost. In this study, the selected regions had the same geographical zoning.

While conducting an ethnographic study in the northern region of Fiji, Carswell (2003) examined the importance of family labour in sugarcane production and the linkage between paid and unpaid labour among small scale sugarcane farms. In the study, it was concluded that labour in this region was undertaken in a gang since majority could not pay labourers to work for them because of poverty. In as much as men were being paid for offering the services, women were hardly paid. As a result, income from the husbands could not sustain the needs of the family, hence many families engaged in other economic activities to supplement their meagre incomes. For the sake of reliability, ethnographic studies are usually unreliable and hence the need have a more robust approach that is more reliable. This study employed inferential statistics with observable data to make it become more reliable.

From the aforementioned literatures, there were no studies that investigated the intra relationships that existed between the costs of different factor inputs in both maize and sugarcane production. This study addressed this intra input relationship and also the inter input relationship inherent in sugarcane production as well as in food production. Considerations were however placed upon the input costs.

Methodology

This study adopted correlational research design to examine the relationship between sugarcane production and maize production among farmers Nyanza region, Kenya. Stratified random sampling generated strata from the sugarcane and maize growing counties of Kisumu, Homabay, and Migori. The choice of this region was premised on the fact that it is the one where both the crops are cultivated in large scale in the region, and sometimes side-by-side through intercropping. The two crops also form the main source of rural households' income, thus supporting their livelihood, and most importantly, also compete for scarce available arable land (Geetha et al., 2015).

The study targeted 317 farmers above 25 years with more than five years' farming experience. Primary data was collected through questionnaires which were tested for reliability via Cronbach's alpha, content validity through experts' opinion, and heteroscedasticity using the Levene's test. In order to establish the relationship between cost of sugarcane production and cost of maize production, under the null hypothesis that cost of sugarcane production is not statistically and significantly related to the cost of maize production, this study employed the use of correlation analysis to confirm any inherent the degree of association as well as regression analysis through Structural Equation Modelling (SEM). This was meant to establish the relationships between the various constructs in sugarcane production and maize production, namely the cost labour, cost of land and cost of capital. Given that there were a number of factors involved in generating the constructs, this study broke down the analysis of correlation into four parts. Part (1) investigated the correlation between the factors that comprised sugarcane production costs, including the costs of labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs. Part (2) involved the investigation of the factors that formed the constructs in the cost of maize production. Similarly, the cost of labour, planting, fertilizers, pesticides, seedlings, irrigation, transport and maintenance or repairs used in maize production was analysed. Part (3) involved the categorization of these costs into the cost of labour, capital and land used in sugarcane production and maize production respectively. Once the sums were generated, correlation analysis depicting the cost of land, labour and capital of sugarcane production was performed on the cost of land, labour and capital used in maize production to study any inherent trade-offs. Finally, in part (4), all the costs in sugarcane production were summed together to form the overall cost of sugarcane production. Similarly, all the costs in maize production were also summed up to form the overall cost of maize production, and then the two were correlated.

Results and Discussion

In this section, there is a discussion on the correlation matrix on the cost elements in sugarcane production and the correlation matrix on cost elements in maize production. The correlation between the costs of constructs in sugarcane and maize production is also discussed, followed by the relationship between cost of sugarcane production and cost of maize production

Correlation Matrix on Cost Elements in Sugarcane Production

From the findings contained in table 1, the level of association between the constructs under the cost of sugarcane production showed that cost of renting land was significant and weakly positively correlated with the cost of labour, planting, fertilizer use and seedling. Coefficients of Correlation were *($r = 0.282, p = 0.000$); ($r = 0.374, p = 0.000$); ($r = 0.113, p = 0.044$); and ($r = 0.290, p = 0.000$)*, respectively. This means that as the cost of renting land increases, the cost of labour, cost of planting, cost of fertilizer-use as well as the cost of seedling are likely to weakly increase.

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Table 1: Correlation Matrix on Cost Elements in Sugarcane Production

		Rent	Labour	Plantin g	Fertilizer	Pesticide	Seedling	Transport	Machinery
Rent	P. Cor	1							
	Sig.								
Labour	P. Cor	.282**	1						
	Sig.	.000							
Planting	P. Cor	.374**	.448**	1					
	Sig.	.000	.000						
Fertilizer	P. Cor	.113*	.212**	.208**	1				
	Sig.	.044	.000	.000					
Pesticide	P. Cor	-.002	.070	.014	.407**	1			
	Sig.	.977	.213	.803	.000				
Seedling	P.Cor	.290**	.150**	.185**	.165**	.061	1		
	Sig.	.000	.008	.001	.003	.276			
Transport	P.Corl	-.027	.079	.023	.059	.024	.199**	1	
	Sig.	.637	.163	.683	.298	.669	.000		
	P.Cor	-.068	-.078	-.038	-.047	.008	-.013	-.064	1
Machinery	Sig.	.230	.163	.501	.407	.882	.813	.258	
	N	317	317	317	317	317	317	317	317

Source: Survey Data (2021)

Moreover, apart from the cost of rent, cost of labour spent in sugarcane production was positively correlated to the cost of planting, fertilizer and seedlings. The coefficients of correlation were *(r = 0.448, p = 0.000); (r = 0.212, p = 0.000); and (r = 0.150, p = 0.008)*, respectively. This means that as the cost of labour increases, the cost of planting, fertilizer and seedlings are also likely to increase significantly. Given this, a percentage change in the cost of labour tended to weakly influence the cost of labour, cost of planting, cost of fertilizers and cost of seedlings. This is in line with findings by Dlamini and Masaku (2013), which also established that labour and fertilizer use were significant in sugarcane production.

Furthermore, the cost of planting is positively and significantly correlated with the cost of fertilizers, pesticides and seedlings. The coefficient of correlation was $(r = 0.208; p = 0.000);(r = 0.407; p = 0.000)$ & $(r = 0.165; p = 0.003)$, respectively. This means that as the cost of labour increases, the cost of fertilizers, pesticides and seedlings are all likely to increase significantly. This implies that a percentage change in the cost of planting tended to weakly influence cost of fertilizers, cost of pesticides and cost of seedlings. This is in line with findings by Zulu et al. (2019) which also observed that fertilizer and chemical applications, positively affected sugarcane production.

Similarly, the cost of fertilizer and cost of planting, cost of seedling in the study area was also significantly correlated with the cost of transport $(r = 0.199; p = 0.000)$. This means that as the as the cost of seedlings increased, the cost of transport was likely to increase significantly.

Correlation Matrix on Cost Elements in Maize Production

In this study, maize production was investigated in terms of its availability; that is, farmers' capacity to avail maize into the nearest markets for sale. To make maize become available, farmers incur various costs to produce it. These costs are on land, capital and labour. Although growing 'own food' may be a necessary condition to maize production, it may not be a sufficient condition since maize can as well be bought or sold from or to the market. Correlation test was also

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performed on the cost elements that comprised the cost of maize production, as presented in table 2.

Table 2: Correlations Matrix on Costs of Maize Production

		Cultivation	Planting	Fertilizer	Pesticide	Seedling	Transport	Maintenance
Cultivation	P.Cor	1						
	Sig.							
Planting	P.Cor	.815**	1					
	Sig.	.000						
Fertilizer	P.Cor	.495**	.399**	1				
	Sig.	.000	.000					
Pesticide	P.Cor	-.003	-.010	.160**	1			
	Sig.	.962	.853	.004				
Seedling	P.Cor	-.070	-.075	.223**	.327**	1		
	Sig.	.216	.185	.000	.000			
Transport	P.Cor	.341**	.468**	.037	.016	-.005	1	
	Sig.	.000	.000	.514	.778	.934		
Maintenance	P.Cor	.217**	.429**	.013	.016	-.010	.714**	1
	Sig.	.000	.000	.822	.781	.861	.000	
	N	317	317	317	317	317	317	317

Source: Survey Data (2021)

The study findings as presented in table 2 indicates that there was a positive and significantly correlation between cost of cultivation and the cost of planting, cost of fertilizer; transport and maintenance *(r = 0.815, p = 0.000); (r = 0.495, p = 0.000); (r = 0.341, p = 0.000); (r = 0.217, p=0.000)*, respectively. This means that there is a strong positive association between the cost of cultivation and the cost of planting, with a corresponding weak association to the cost of fertilizer, cost of transport and cost of maintenance.

In addition, the cost of planting was significant and positively correlated with the cost of fertilizers (r = 0.399; p = 0.000), cost of transport (r = 0.468; p = 0.000) and to the cost of repairs (r = 0.429; 0.000). This means that there is a weak positive association between the cost of planting, the cost of fertilizer, cost of transport and the cost of repairs in the study area.

The cost of fertilizers was positively and significantly correlated with the costs of pesticides (r = 0.160; p = 0.000) and cost of seedlings (r = 0.223; p = 0.000). This meant that there is a weak positive association between the cost of fertilizer the cost of pesticides and the cost of seedlings. Cost of pesticides were significant and positively but is weakly correlated to the cost of seedlings $(r = 0.327; p = 0.000)$.

Correlation between the Costs of Constructs in Sugarcane and Maize Production

Having investigated the correlations between the costs of the various factors used in both the production of sugarcane and maize, a summary of these costs was grouped into three categories; namely, cost of land, cost of labour and cost of capital. As such, these input production factors formed the ultimate constructs in the analysis on the cost of sugarcane production as well as cost of maize production, as presented in table 3.

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Table 3: Correlation Matrix between Cost Elements in Sugarcane and Maize Production

		Labour(S)	Capital(S)	Land(S)	Labour(F)	Capital(F)	Land(F)
Labour (S)	Pearson Correlation	1					
	Sig. (2-tailed)						
Capital (S)	Pearson Correlation	.380**	1				
	Sig. (2-tailed)	.000					
Land (S)	Pearson Correlation	.560**	.268**	1			
	Sig. (2-tailed)	.000	.000				
Labour (F)	Pearson Correlation	.091	.180**	.060	1		
	Sig. (2-tailed)	.105	.001	.284			
Capital (F)	Pearson Correlation	.019	.075	-.014	.296**	1	
	Sig. (2-tailed)	.733	.180	.798	.000		
Land (F)	Pearson Correlation	.296**	.235**	.614**	-.057	-.072	1
	Sig. (2-tailed)	.000	.000	.000	.312	.201	
	N	317	317	317	317	317	317

**. Correlation is significant at the 0.01 level (2-tailed); (S)= Sugarcane; (F)= Maize crops
Source: Survey Data (2021)

Based on results in table 3, the cost of factors of production used in sugarcane production was correlated with the cost of factors used in maize production. The correlation results indicate that the cost of labour in sugarcane production was positively correlated with cost of capital used in sugarcane production, cost of land in sugarcane production as well as cost of land used in maize production. The coefficient of correlation was $(r = 0.380; p = 0.000)$; $(r = 0.560; p = 0.000)$ $(r = 0.296; p = 0.000)$, respectively. This, therefore, means that as the cost of labour in sugarcane production tend to increase in the study area, the cost of capital in sugarcane production also tend to weakly increase, cost of land in sugarcane production tend to strongly increase and the cost of land in maize production also tend to weakly increase.

In addition, the cost of capital in sugarcane production was significant and positively correlated with the cost of land in sugarcane production (r =0.268; p =0.000); cost of labour in maize production as well as cost of cost of land in maize production. The correlation coefficients were $(r = 0.180; p = 0.001)$;$(r = 0.235; p = 0.000)$ respectively. This meant that as the cost of capital in sugarcane production in the study area tend to increase, the cost of land in sugarcane production also tend to weakly increase; the per unit cost of labour in maize production tend to weakly increase and the cost of per unit cost of land in maize production also tend to weakly increase.

Furthermore, the cost of land in sugarcane production was also significant and positively correlated with the cost of land in maize production $(r = 0.614; p = 0.000)$. This means that as the

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cost of land in sugarcane production tend to increase, the cost of land in maize production also tends to strongly increase.

Moreover, given that the cost of labour in maize production was significant and positively correlated with the cost of capital in maize production $(r = 0.296; p = 0.000)$, it means that as the cost of labour tended to increase, the cost of capital in maize production also tends to weakly increase. The results are in tandem with the findings of Agidew and Singh (2018), which observed that labour is a significant determinant of food production.

Relationship between Cost of Sugarcane Production and Cost of Maize Production

Once correlation was established, the structural equation model was applied to regress the cost of sugarcane production against cost of maize production. The Structural Equation Modelling carried out IS shown in figure 1.

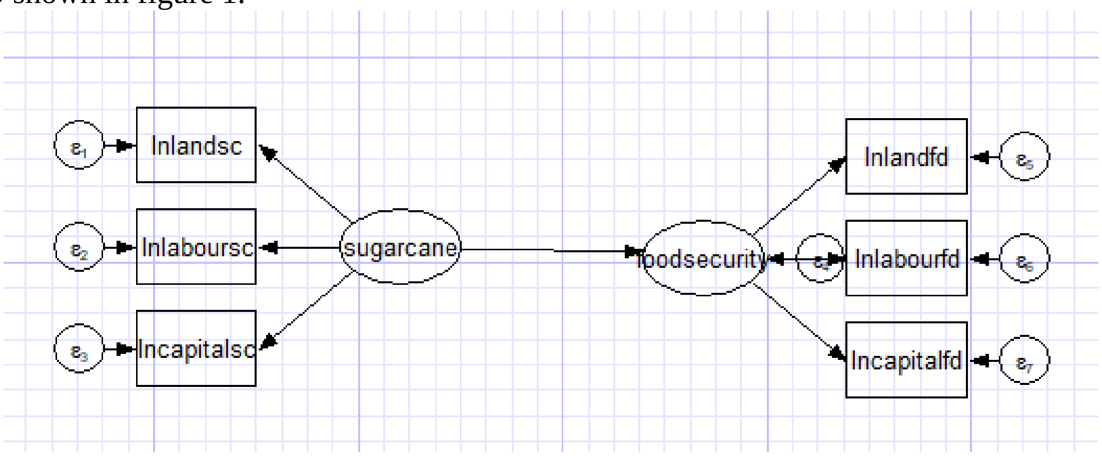

Fig.1: Relationship between Cost of Sugarcane Production and Maize production
Source: Survey Data (2021)

According to figure 1, the cost of sugarcane production contained three constructs; namely, the cost of land, the cost of labour and the cost of sugarcane. Similarly, the cost of maize production also contained the cost of land, cost of labour as well as the cost of capital as its constructs. The arrow from sugarcane to maize is the investigative indicator from the independent variable to the dependent variable. Results from the Structural Equation Model are captured in table 4.

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Table 4: Structural Equation Model of Sugarcane Production on Maize production

Structural equation model			Number of obs	= 317
Estimation method = mlmv				
Log likelihood = -1305.8945				
	Coef.	OIM Std. Err.	z	P>|z|
Structural				
Maize production				
Sugarcane	.689	.219	3.15	0.002
Measurement				
lnland(sc)				
Sugarcane	1	(constrained)		
Cons	9.622	.037	258.21	0.000
lnlabour (sc)				
Sugarcane	1.465	.446	3.28	0.001
Cons	9.307	.066	141.32	0.000
Sugarcane	1.590	.381	4.17	0.000
lncapital(sc)				
Cons	9.466	.0706	134.00	0.000
lnland(fd)				
Maize production	1	(constrained)		
Cons	8.922	.042	213.23	0.000
lnlabour(fd)				
Maize production	2.810	.945	2.97	0.003
Cons	8.574	.091	94.22	0.000
lncapital(fd)				
Maize production	2.984	.857	3.48	0.000
Cons	8.600	.081	106.71	0.000

LR test of model vs. saturated: chi2 (8) = 29.95, Prob > chi2 = 0.0002; R-square =0.833 Sc= sugarcane; fd = food

Source: Survey Data (2021)

From the findings presented in table 4, the cost of sugarcane production is positive and significant in the determination of cost of maize production $(\alpha_1 = 0.689; p = 0.002)$. This implies that the level of responsiveness to changes in the cost of maize due to changes in the cost of sugarcane production is positive, significant but inelastic; that is, as the cost of sugarcane production changes (increases) by a certain proportion, the cost of maize production also changes but by less than the proportionate increase in the cost of sugarcane production. This result is in consonance with Gunatilake and Abeygunawardena (2011) who observed that production of sugarcane compromised food production. In this case, if the cost of sugarcane production increases, it inadvertently leads to increased cost on maize production which potentially reduces its production.

With regard to the cost of the constructs (inputs) required in sugarcane farming, the level of responsiveness to changes in the cost of sugarcane production due to changes in the cost of labour is elastic, positive and significant $(\alpha_2 = 1.465; p = 0.001)$. Similarly, the level of responsiveness to changes in the cost of sugarcane production due to changes in the cost of capital is elastic, positive and significant $(\alpha_3 = 1.590; p = 0.000)$. This means that as the cost of labour and cost of capital changes in the study area, the cost of sugarcane production also changes by more than the proportionate change in the cost of labour and cost of capital, respectively.

With regard to the cost of inputs used in maize production, the level of responsiveness to cost of maize production due to changes in the cost of labour was elastic, positive and significant $(\alpha_4 = 2.810; p = 0.003)$. Similarly, the level of responsiveness to the cost of maize production due to changes in the cost of capital used in maize production was elastic, positive and significant $(\alpha_5 = 2.984; p = 0.000)$. All these findings means that as the cost of labour and cost of capital change by a given percentage, the cost of maize production changes by 2.810 times the change in the cost of labour and 2.984 times the change in the cost of capital. These findings are in line with those of Zulu et al. (2019) as well as findings by Agidew and Singh (2018) which observed that labour is significant in both sugarcane and maize production respectively.

The goodness of fit was 0.833; meaning that the overall cost of sugarcane production explained 83.3 percent variations in the cost of maize production. As such, the alternative hypothesis was accepted; that is, cost of sugarcane production significantly influences the cost of maize production in Nyanza region of Kenya.

Conclusion

This study concludes that there is a relationship between the cost of sugarcane production and the cost of maize production, with implication for food security meant for rural households. However, changes in the cost of sugarcane production positively and significantly affect the cost of maize production although this relationship is inelastic. Given that the cost of maize production is positive and significantly varies with cost of sugarcane production although inelastic, this study recommends for an in-depth analysis of the cost of sugarcane production, ceteris paribus. Policy measures should be placed to tame ad hoc increases in the cost of sugarcane production since such cost increases inadvertently results into increases in the cost of maize production, as this could affect the livelihood of the rural households in Nyanza region of Kenya. Similarly, future research should focus on the relationship between sugarcane output and maize output and consider seasonal production of both.

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